ITU/BDT Regional Seminar on

Costs and Tariffs for Member Countries of the Tariff Group for Africa (TAF)

Midrand, South Africa, June 2005

NGN Network Architecture

Oscar González Soto
ITU Consultant Expert
Strategic Planning and Assessment

NGN Network Architecture
Content

- NGN concepts
  - Concepts and motivation
  - Requirements
- Network architecture
  - Functional Network
  - Network elements and protocols
- Network design issues
  - Dimensioning for multiple flows
  - Cost drivers and trends

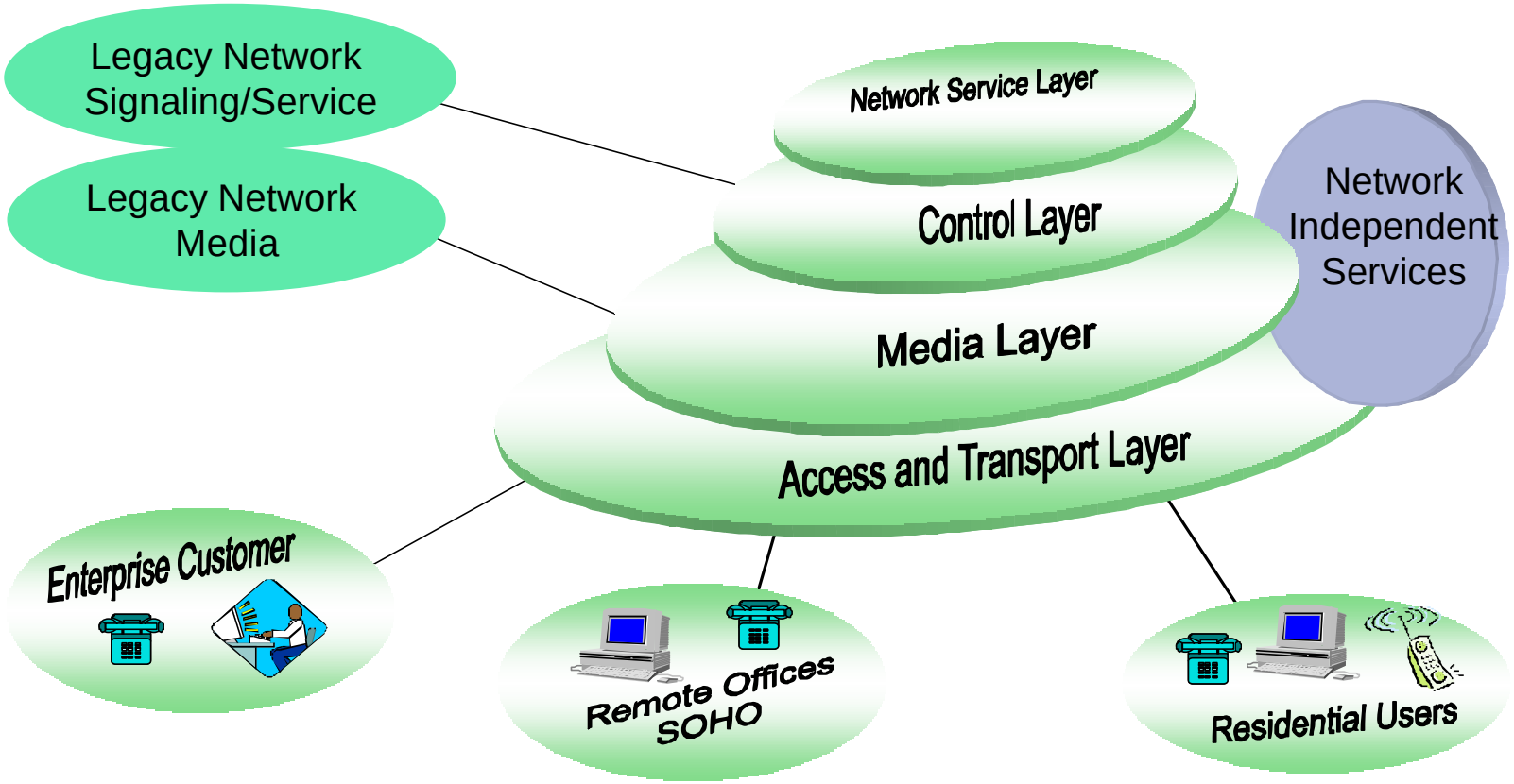
NGN Network Architecture
NGN concept

- A **multi-service network** able to support voice, data and video
- A network with a control plane (signaling, control) **separated** from the transport/switching plane
- A network with **open interfaces** between transport, control and applications
- A network using **packet mode technology** to transport of all kind of information
- A network with **guaranteed QoS** for different traffic types and SLAs

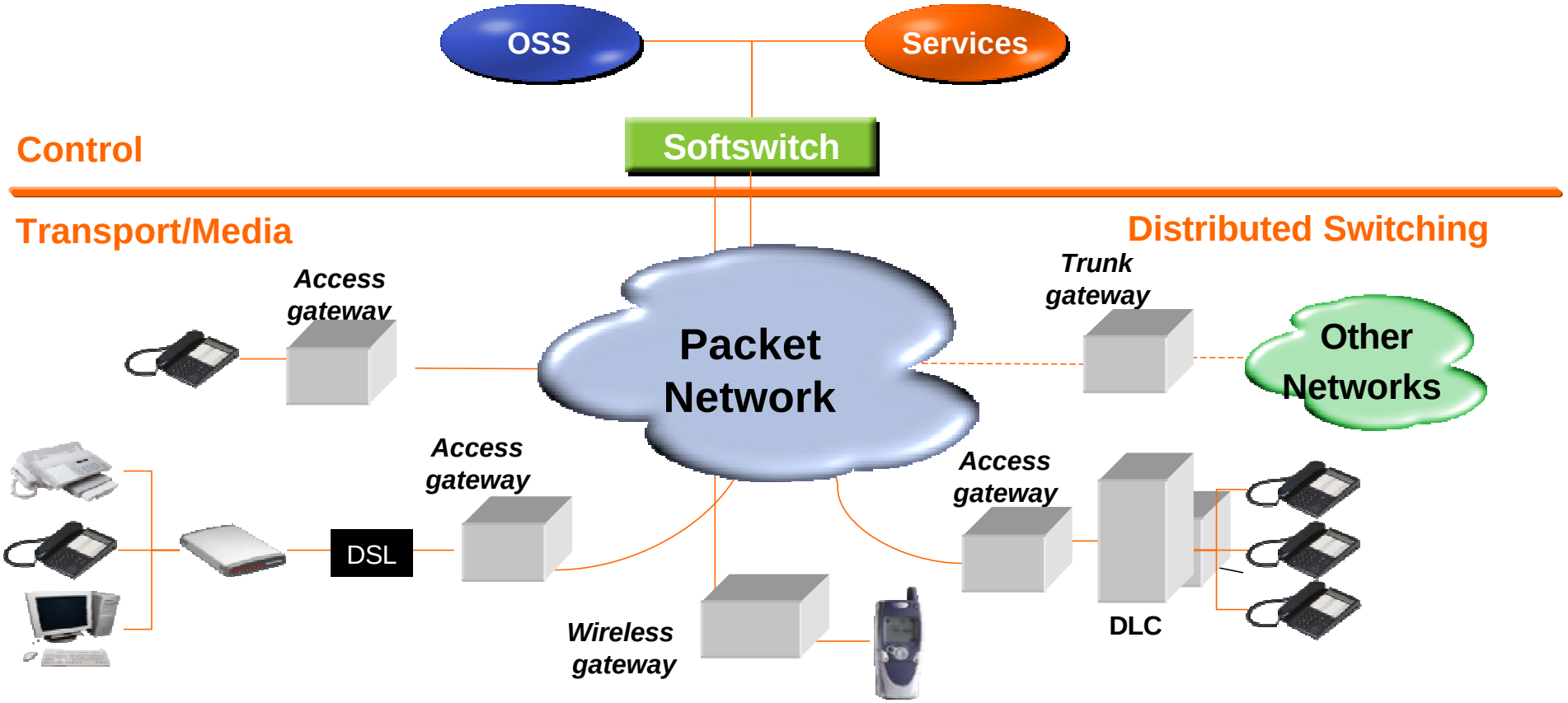
NGN Network Architecture
Why

- **Flexibility** for service building and offering
- Expectation of **cost reductions** by sharing infrastructure and systems
- **Simplification of O&M**, thus lowering OPEX.
- Use of **open interfaces** leads for:
  - quick deployment of services and applications
  - new services (third parties)

NGN Network Architecture
NGN Layers



NGN Network Architecture
Target architecture



NGN Network Architecture
Key Factors: Operator Requirements(I)

- **Business continuity** required to maintain ongoing dominant services and customers that require carrier-grade service

- **Flexibility** to incorporate existing new services and react quickly to the ones that appear on real time (main advantage of IP mode)

- **Profitability** to allow feasible return on investments and in the best practices market values

NGN Network Architecture
Key Factors: Operator Requirements (II)

- **Survivabilty** to allow service assurance in case of failures and external unexpected events

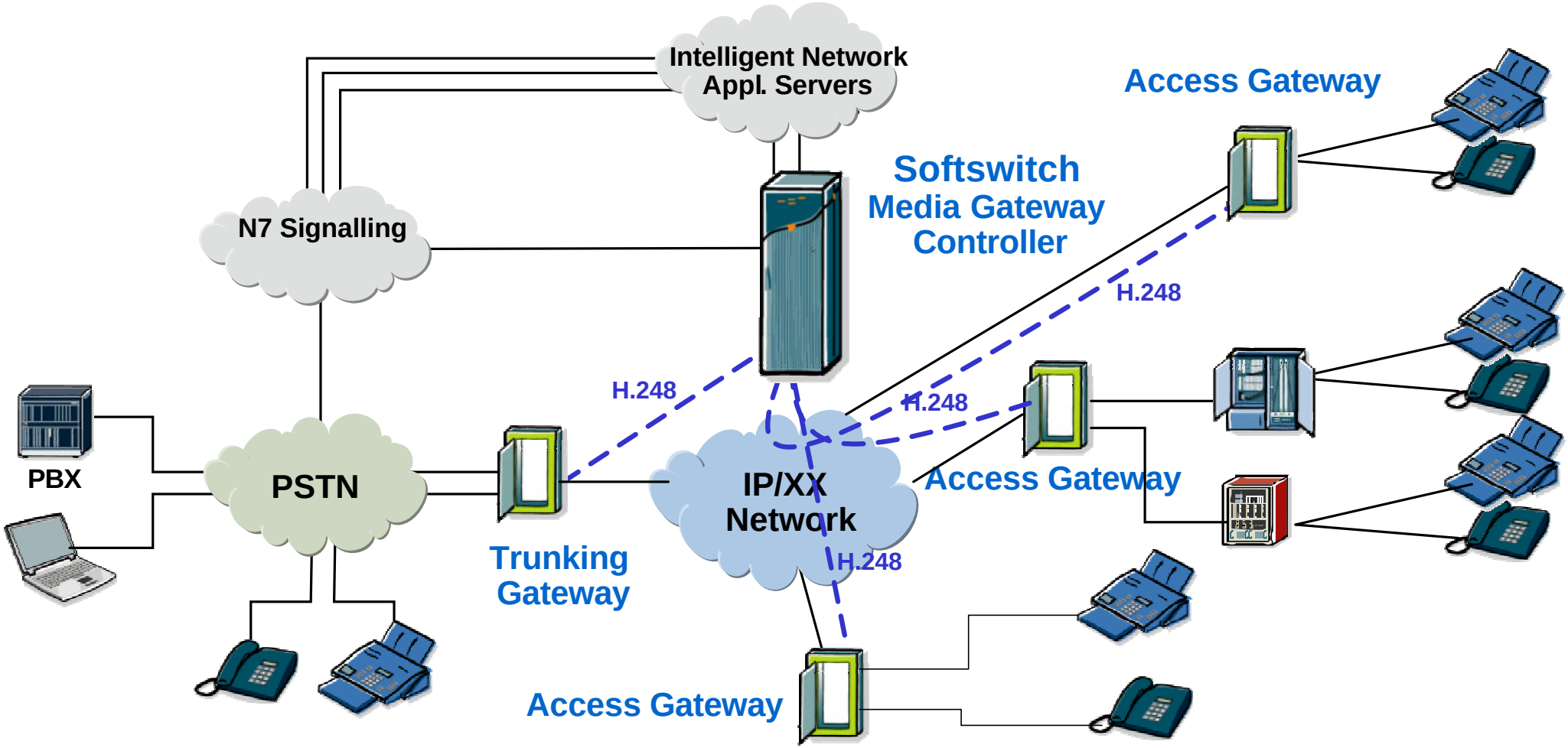
- **Quality of Service** to guarantee the **Service Level Agreements** for different traffic mixes, conditions and overload.

- **Interoperabilty across networks** to allow to carry end to end services for flows in different network domains

NGN Network Architecture
Content

- **NGN concepts**
  - **Concepts and motivation**
  - **Requirements**
- **Network architecture**
  - **Functional Network**
  - **Network elements and protocols**
- **Network design issues**
  - **Dimensioning for multiple flows**
  - **Cost drivers and trends**

NGN Network Architecture
Network Architecture



NGN Network Architecture
Network Elements

- **Packet based networks**
  - – Trend is to use IP based networks over various transport possibilities (ATM, SDH, WDM…)
  - – IP based networks must offer guarantees of Quality of Service (QoS) regarding the real time characteristics of voice, video and multimedia
- **Access Gateways**
  - – Allows the connection of subscriber lines to the packet network
  - – Converts the traffic flows of analogue access (Pots) or 2 Mb/s access devices into packets
  - – Provides subscriber access to NGN network and services
- **Trunking Gateways**
  - – Allows interworking between classical TDM telephony network and Packet-based NGN networks,
  - – Converts TDM circuits/ trunks (64kbps) flows into data packets, and vice versa

NGN Network Architecture
Network Elements

- **Softswitch/MGC**
  - – referred to as the Call Agent or Media Gateway Controller (MGC).
  - – provides the "service delivery control" within the network
  - – in charge of Call Control and handling of Media Gateways control (Access and/or Trunking) via H.248 protocol
  - – performs signalling gateway functionality or uses a signalling gateway for interworking with PSTN N7 signalling network
  - – provides connection to Intelligent Network /applications servers to offer the same services as those available to TDM subscribers
- **Application Server (AS)**:
  - – A unit that supports service execution, e.g. to control Call Servers and NGN special resources (e.g. media server, message server).

NGN Network Architecture
Network Elements

- **H.248 Protocol**
  - – Known also as MEGACO: standard protocol, defined by ITU-T, for signalling and session management needed during a communication between a media gateway, and the media gateway controller managing it
  - – H.248/MEGACO allows to set up, keep, and terminate calls between multiple endpoints as between telephone subscribers using the TDM
- **SIP**
  - – Session Initiation Protocol in order to handle call establishment, maintenance and termination from packet mode terminals.
- **Signalling Gateway (SG):**
  - – A unit that provides signalling conversion between the NGN and the other networks (e.g. STP in SS7).

NGN Network Architecture
Network Elements

- **ENUM**
  - – Electronic NUMbering: Protocol that allows to establish a correspondance between the traditional telafone numbering (E.164) and the network addresses related to the packet mode networks (RFC 2916 "E.164 number and DNS" IETF).

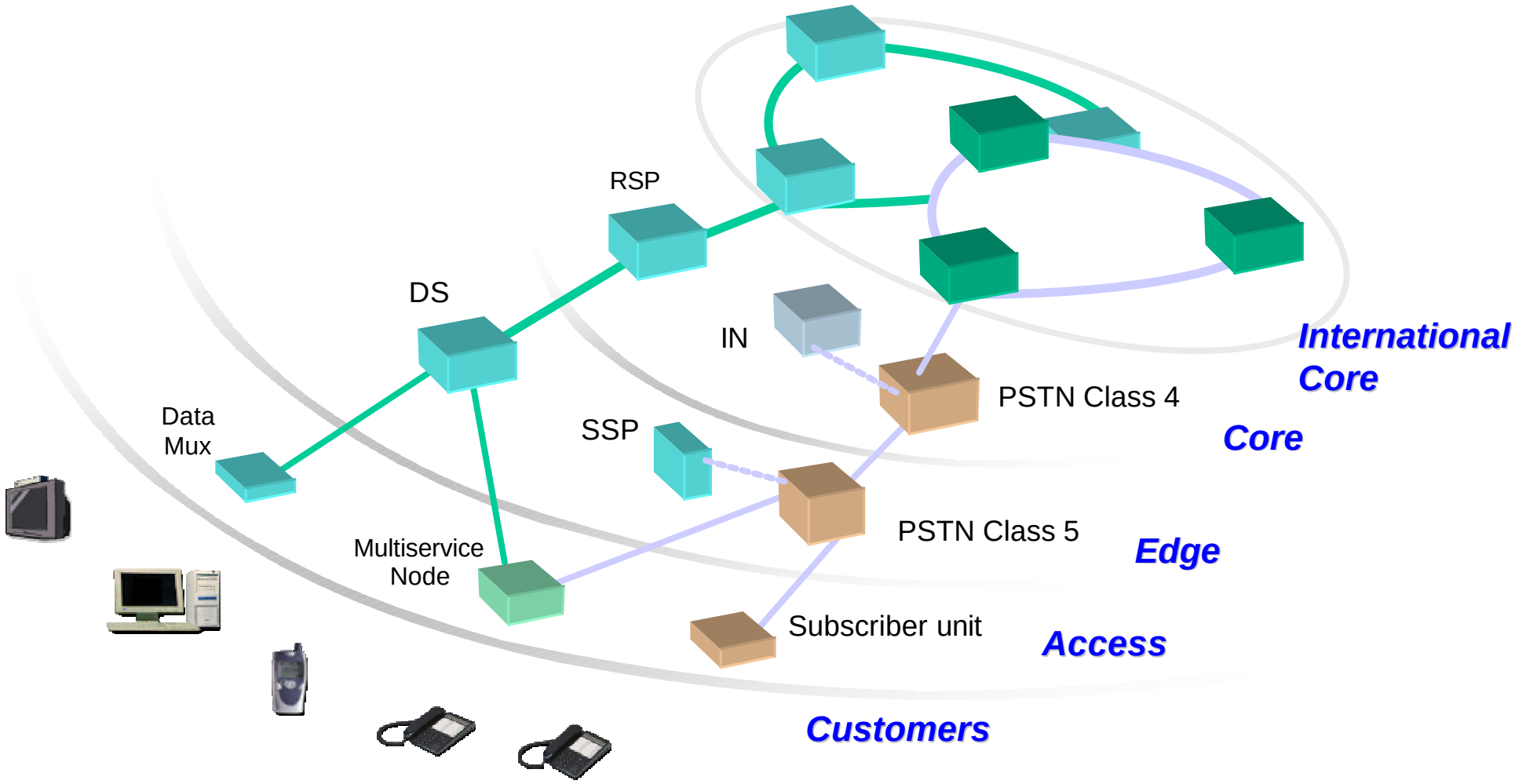
- **MPLS**
  - – Multiprotocol Label Switch or protocol that assigns labels to information packets in order to allow the node routers to treat and route flows in the network paths according to established priority for each category.
- **CAC**
  - – Call Acceptance Control function in order to accept/reject traffic in the network that allows guarantee of QoS for services with a Service Level Agreement
- **BGP**
  - – Border Gateway Protocol to negotiate flow routing procedures and capacities across different NGN network domains

NGN Network Architecture
Architecture Consolidation: Topology

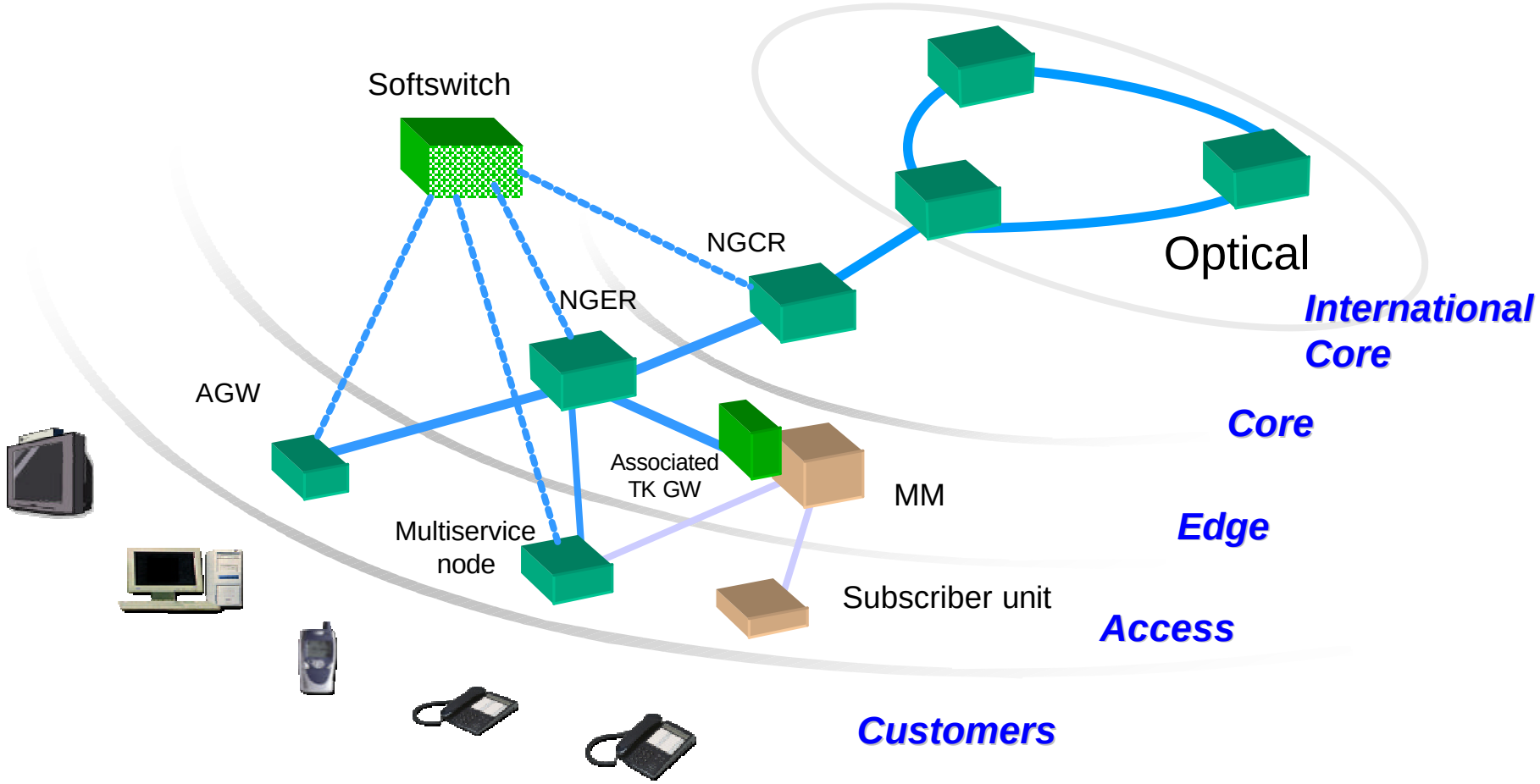
Topological changes impact on infrastructure and are slower to implement than technology substitution

- **Less network nodes and links** due to the higher capacity of systems (one order of magnitude).
- **Same capilarity** at access level due to identical customer location
- Topological **connectivity higher** for high capacity nodes and paths for security
- **High protection** level and diversity paths/sources in all high capacity systems, both at functional and physical levels

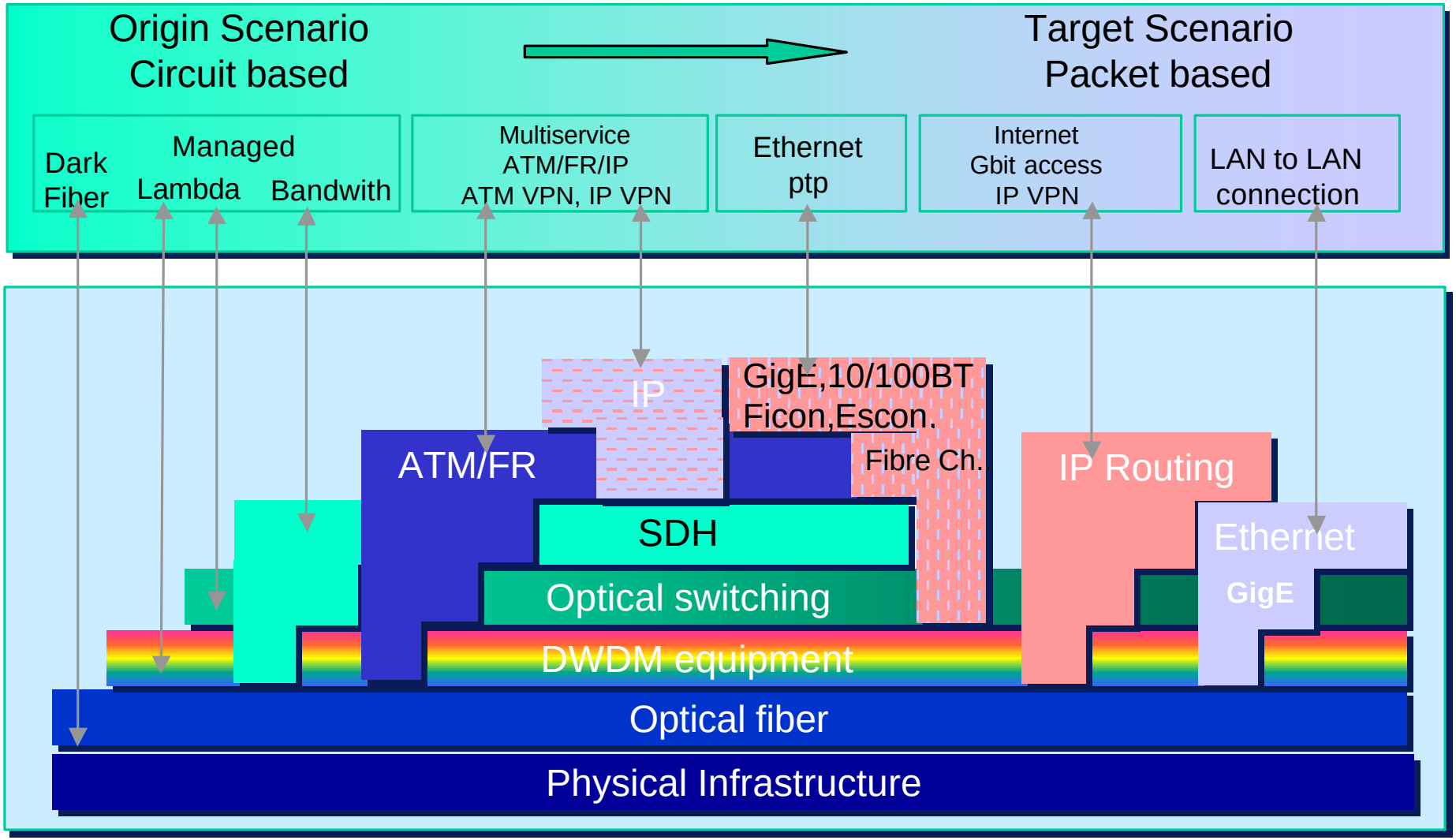
NGN Network Architecture
Overall Architecture



NGN Network Architecture
Overall Architecture



NGN Network Architecture
Technological alternatives at core



NGN Network Architecture Content

- NGN concepts
  - Concepts and motivation
  - Requirements
- Network architecture
  - Functional Network
  - Network elements and protocols
- Network design issues
  - Dimensioning for multiple flows
  - Cost drivers and trends

NGN Network Architecture
The Network Design Criteria

- A) Match realistic service demands and workloads for a given time
  - Node and links loads based on proper multiservice flow **characterization**, measurements and projections
- B) Consider equilibrium between QoS and cost
  - **Statistical behavior** for the flows
  - Traffic modeling for given **quality, efficiency and protection**
  - **Overload** protection and control
- C) Anticipate capacity as a function of service grow rate and needed installation time. **Reserve capacity**
- D) Follow **SLA** when different service classes coexist

NGN Network Architecture
Network Design and Dimensioning
The 5 basic Traffic activities

- Traffic **Characterization** for services and network flows
- Traffic **Demand** forecasting and aggregation at the user and Network interfaces
- Traffic **Dimensioning** for all network elements
- Traffic **Measurements** and Validation for key parameters
- Traffic **Management** in focussed and generalized overload

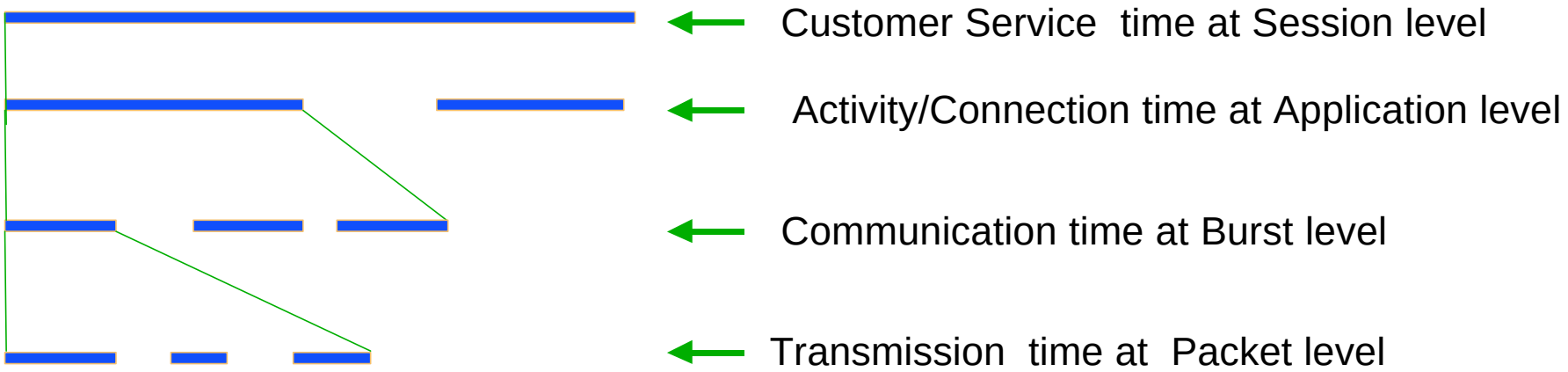
NGN Network Architecture
Network Design and Dimensioning

Service demand Characterization

- By a profile through days in a year/week
- By a busy period within a day
- By superposition of non-coincidence of busy periods (for inter-country traffic in different time zone)
- By aggregation or convolution of flows for different services
- By interest factors between areas (adjusting matrices in the two dimensions ie: Kruithof, affinity, correlation)

NGN Network Architecture
Traffic Characterization

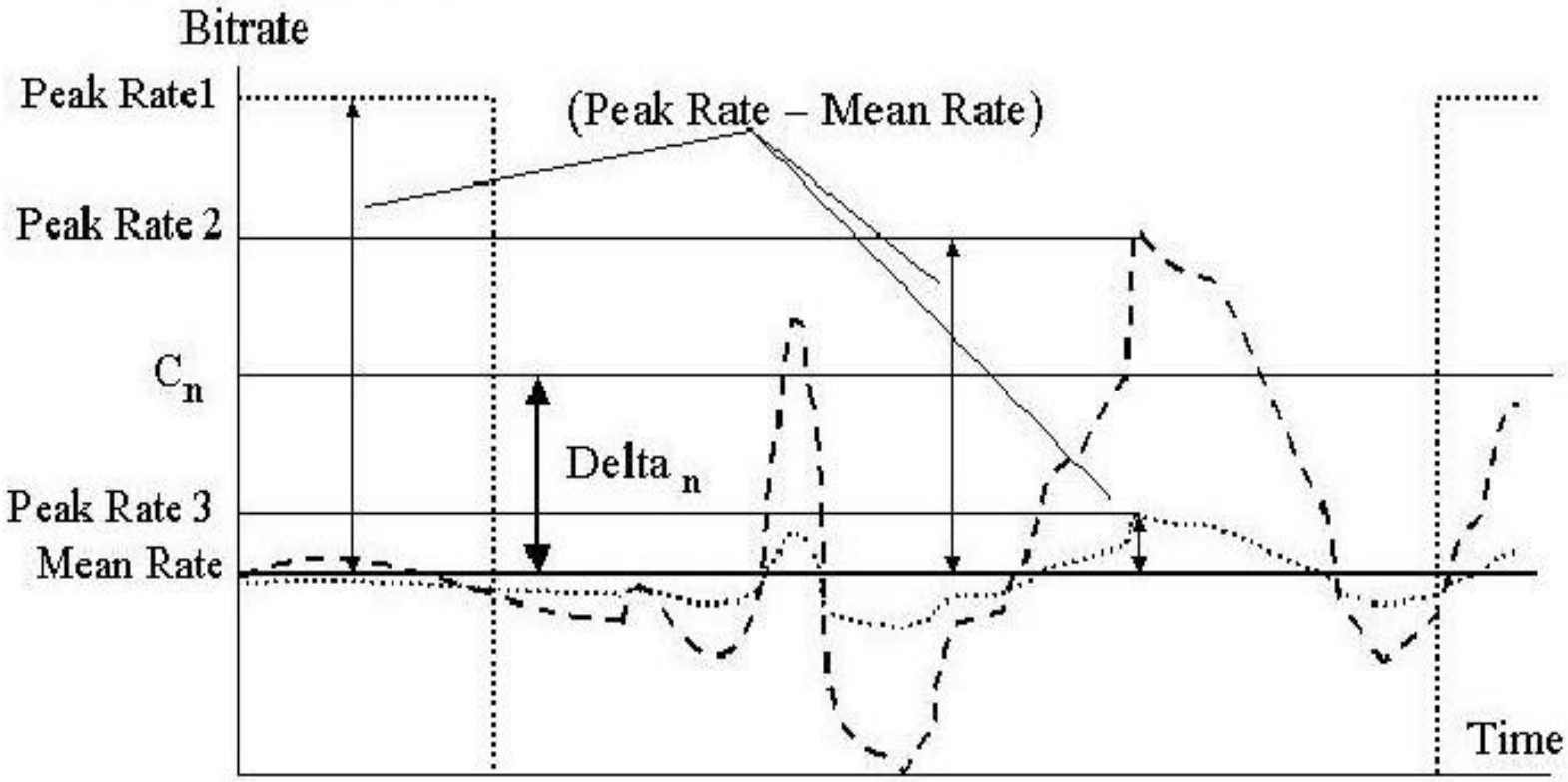
- Generalized utilization time and levels per user activity in the busy period : Example for IP mode



- Aggregated average traffic per level as a weighted average of the services (i) and customer classes (j) at that level.

NGN Network Architecture
Traffic Characterization

- Different relation between peak traffic and average traffic per service classes: CBR (1), VBR(2), VBR(3)



NGN Network Architecture
Traffic Characterization

- Traffic Units definition
  - At call, session and packet level
  - Needed additional clarification on the different type of traffic averages and meaning (CBR,SBR, Billed)

- Reference periods
  - Should be common when aggregating services to ensure validity and represent behavior of IP flows
- Statistical laws
  - For calls, sessions and packets

- Aggregation process
  - Considering reference period above and coincidence/non-coincidence of busy periods among services

NGN Network Architecture
Traffic flow types for Quality of Service based dimensioning

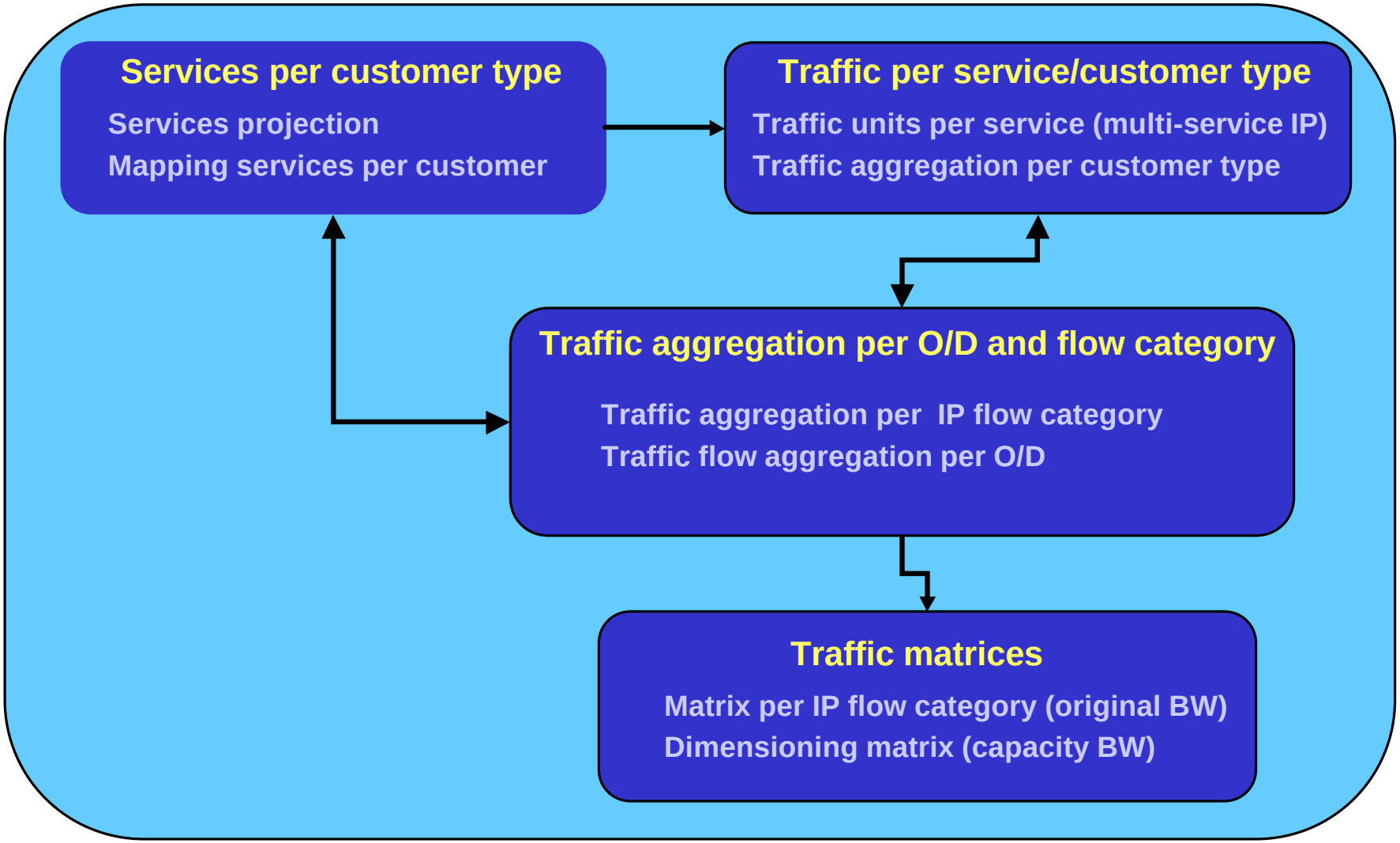
- **QoS constant stream**: bandwidth transmission at a constant speed with a specified delivery and jitter (ie: video distribution)
- **QoS variable stream** : bandwidth transmission at a variable speed derived from a user information and coding algorithm which requires guaranteed quality and specified jitter (ie: VoIP, Video streaming, audio streaming, etc.)
- **QoS elastic:** bandwidth transmission at a variable speed without jitter restrictions and asynchronous delivery (ie: browsing, file transfer, mail, UMS, etc.)

NGN Network Architecture
Traffic Flows to be modeled

To simplify analysis, the following partition is made:

- **L1) Global Network Level**
  - Overall topological network (access and/or core) including routing procedures and all alternative paths.
- **L2) End to End Path or sub-path**
  - For different user type scenarios: VoIP to VoIP, VoIP to POTS, etc. and network segments: user to LEX, user to GW, etc.
- **L3) Network Elements**
  - For Network Nodes
    - LEX, RSU,POP,GW, SS, TGW,IP router, etc.
  - Network Links
    - At functional, transmission and physical levels

NGN Network Architecture
NGN Service demand evaluation process



NGN Network Architecture
Cost drivers and trends

- Network physical infrastructure as a function of location and density (costs proportion around 70% in the access segment)
- Volume of customers per category
- Bandwidth demand per origin/destination
- Packet processing rates for control related functions
- Variety of applications/services and related platforms
- Content storage and location within the network
- Leasing of physical or communication resources

Fundamental importance of economies of scale by volume and convergence at network resources, service platforms and OSS

NGN Network Architecture
Cost drivers and trends

Cost trends for NGN

- Cost reduction in CAPEX due to technological economy of scale by larger capacities
- Similar values for costs in the physical civil infrastructure
- OPEX in NGN trends to be lower due to the integrated operation and maintenance
- Plan higher investments in security/survivability with diversity paths and protection for large capacity systems

Check and validate correct cost modelling with fixed and variable components as a function of economy of scale

NGN Network Architecture
Summary of Key Concepts

- Multimedia open service network.
- Applications and control functions separated from media
- Guarantee of Quality of Service needed
- Motivated by new services, flexibility and cost reductions
- Maturity level progressing and needing consolidation